New dislocation-related photoluminescence from ZnSe grown on in-situ cleaved (110) GaAs

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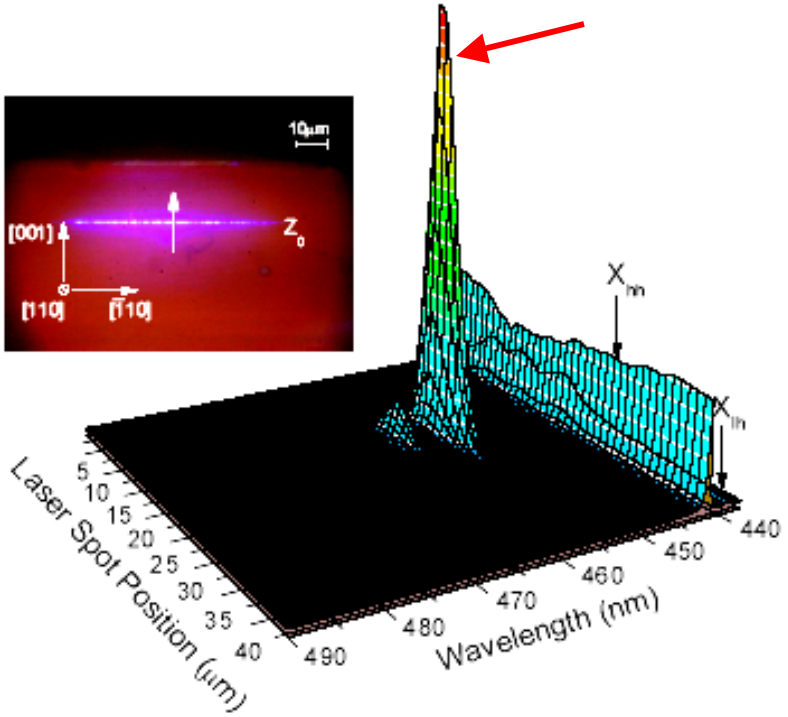
ZnSe/GaAs-based heterostructures constitute an important base for wide-gap optoelectronic devices. Ultimately, the quality and the life-time of light emitting diodes and lasers based on ZnSe/GaAs is limited by misfit dislocations which form during the growth of this materials combination. Understanding the role which dislocations play in radiative processes in ZnSe/GaAs is therefore essential. We have recently discovered a new dislocation-related luminescence which occurs in ZnSe when it is grown on GaAs along the [110]. The relationship of the luminescence to the dislocation structure is expected to shed valuable new light on the dislocation formation process.



Micro-photoluminescence spectra for a ZnSe layer grown on a (011) GaAs surface mapped by consecutive scans taken in 1 μm steps. The image of the surface of the sample is taken by a CCD camera. The sharp maximum of the PL signal (indicated by the red arrow) which corresponds to the blue streak is the new dislocation-related emission.

A wide class of optical devices is based on thin layers of ZnSe grown on top of GaAs substrate by molecular beam epitaxy. During the growth defects

involving dislocation of atomic positions in the ZnSe crystal can form. Such dislocations are undesirable, because they impair the efficiency of light emitting devices and shorten their lives. It is therefore important to understand how dislocations form, as well what role they play in the emission of light in optical devices. In studying the optical properties of thin ZnSe films, we have discovered a new dislocation that forms when the ZnSe is grown along a particular crystallographic direction. We hope that by studying the properties of this newly-discovered dislocation we can shed additional light on the process of how and why dislocations form during the growth of a crystal. This understanding may lead us to reduce the effect of dislocations on the performance of optoelectronic devices, such as light emitting diodes and semiconductor lasers.

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Education:

One undergraduate REU student (Elizabeth Martin); one graduate student (Lubov Titova), one exchange student from the Institute of Physics of the Polish Academy of Sciences (G. Cywinski); and a post-doc (Miroslaw Kutrowski) contributed to this work. Elizabeth Martin is an REU student, and just graduated from the University of Notre Dame. Lubov Titova received her Ph.D. in June 2004.

Societal Impact:

Our group has been continually active as a resource of materials for other research groups. We are currently interacting with at least 25 other institutions by providing them with specimens. Thus additional understanding of defect formation during molecular beam epitaxy carried out in our laboratory is automatically of benefit to our collaborators who depend on the quality of materials which we provide.